Preliminary Dispersion Modeling for the NuStart Plant at Bellefonte

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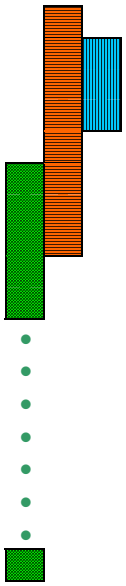
Introduction

TVA halted construction of the Bellefonte Nuclear Plant, located near Scottsboro, Ala., in 1988 and placed the two nuclear units in deferred status. In July 2005, TVA decided to amortize these units. TVA recently cancelled its construction permit with the NRC for these units. These actions, however, did not limit TVA's ability to use the Bellefonte site in the future for other applications.

Meteorological data were collected at the Bellefonte site from 1972 to 1983. Temporary tower data were collected from 10 meter and 40 meter towers from 1972 to 1978. Permanent tower data were collected from a 110 tower from 1975 to 1983. The tower was removed but the environmental data station (EDS) was left. A wind flow study[1] was performed at Bellefonte in 1993 using a sodar at the site of the previous permanent tower and a 21 meter tower on an escarpment 3.1 kilometers east southeast of the sodar site. All of these data were validated and archived by TVA. Later, TVA's Transmission Power Supply group began using the previous monitoring location as a training facility. This included erecting a 55 meter tower at the same location of the previous tower. Table 1 shows a timeline of the Bellefonte meteorological monitoring.

Table 1 - Bellefonte Meteorological Monitoring History:

Date	Action
May 12, 1972	[Temporary Offsite Tower] Begin meteorological data collection.
Oct 20, 1972	[Temporary Onsite Tower] Begin meteorological data collection.
Oct 10, 1974	[Temporary Onsite Tower] End meteorological data collection.
Oct 29, 1975	**[Permanent Onsite Tower] Begin meteorological data collection.**
Jul 31, 1978	[Temporary Offsite Tower] End meteorological data collection.
Nov, 1, 1983	**[Permanent Onsite Tower] End meteorological data collection.**
Jan 1, 1990	Start PSD meteorological monitoring (10m WS/WD only).
Jan 31, 1991	End PSD meteorological monitoring.
Apr 1, 1993	Start SODAR wind flow study.
Jul 7, 1993	Start SODAR wind flow study.
April 1, 2006	**[Permanent Onsite Tower] Restart meteorological data collection.**



In September 2005, NuStart Energy Development LLC, the nation's largest consortium of nuclear power companies, selected TVA's Bellefonte Nuclear Plant as one of the two best sites in the country for a new nuclear plant. It is seeking a Combined Construction & Operating License from the Nuclear Regulatory Commission for the site using a passive-reactor design, particularly the Westinghouse AP1000. TVA is a participating member of NuStart Energy with the objective of supporting the advancement of new reactor technologies. Figure 1 shows a conceptual layout of the AP1000 at the Bellefonte site.

Figure 1 - Schematic of Westinghouse AP1000

Background

In October 2005, NuStart Energy requested TVA to examine the Bellefonte meteorological monitoring history and determine the requirements for meteorological data for a combined operating license application (COLA). Three specific NRC requirements[2] were determined to be applicable:

- Onsite meteorological measurements programs should produce data which can be summarized to provide a description of the meteorological characteristics of the site and its vicinity . . . and for comparison with offsite sources to determine the appropriateness of climatological data used for design considerations.
- For the Final Safety Analysis Report (FSAR) or COLA, at least two consecutive annual cycles, including the most recent 1-year period, should be provided at docketing.

- Onsite meteorological monitoring equipment must be able to provide real-time meteorological information necessary to verify adequate dose projection capability during radiological emergencies.

The conclusions from this evaluation were:

- Meteorological measurements at the local site reasonably represent conditions at surrounding locations and short-term measurements are representative of longer-term periods.

- The last complete year of data collected at the permanent meteorological monitoring facility is more than 20 years old so it will not be acceptable as "the most recent 1-year period".

- The Emergency Planning Zone (EPZ) encompasses an escarpment 2 kilometers to the southeast, which rises to 250 meters above plant elevation. Based on the results of the Bellefonte wind flow study during 1993, it was determined that "meteorological data collected . . . in the valley do not adequately represent meteorological conditions in the Bellefonte vicinity (10-mile EPZ) for emergency preparedness applications."

In December 2005, NuStart Energy asked TVA to evaluate whether the 55 meter tower location would be an acceptable location to collect an additional year of meteorological data for the COLA. TVA concluded that it would be acceptable and NuStart Energy concurred. Installation of new equipment was requested in January 2006 using guidance from ANS-3.11 (2005).[3] Operation began in April 2006 and valid data collection began in May 2006. Figure 2 shows the current Bellefonte meteorological tower.

Figure 2 - Bellefonte Meteorological Tower

The Westinghouse AP1000 Design Control Tier 1 Document identifies key site parameter specifications related to the design of safety-related aspects of structures, systems, and components for the AP1000. An actual site is deemed acceptable if its site characteristics fall within these plant site design parameters. These parameters include Atmospheric Dispersion Factors (χ/Q) for the site boundary, for the low population zone, and for Control Room and Heating Ventilation and Air Conditioning intakes for accident dose analysis. Westinghouse expressed concern with the proximity of a portion of the site boundary at Bellefonte to the desired plant location and its potential impact to the χ/Q. At its closest point, the site boundary is only a distance 343 meters from the plant.

TVA performed an analysis to determine if the χ/Q parameter met the design specification for the AP1000. Since this analysis could impact the acceptability of the site, an answer was needed prior to the collection of another year of onsite meteorological data. Therefore, previous meteorological data collected onsite from 1979-1982 were used in the analysis. A model developed in-house by TVA based on R. G 1.145[4] methodology was used in conjunction with geometric source data for the AP1000 (i.e., release height and minimum cross-sectional area of the plant buildings. The NRC's PAVAN model[5] was also used to verify the reasonableness of the results

Results

The χ/Q analysis indicated that the worst case site boundary χ/Q would exceed the site parameter specification by about a factor of 2 to 3. Design basis accidents were treated as ground-level releases and utilized 10 meter wind speed and direction and the 10 to 46 meter temperatures for stability class. The worst case condition was the 0-2 hour χ/Q that was exceeded 5% of the time. A question was raised whether the site parameter specification was the 50th percentile or the 5th percentile value. Investigation by Westinghouse confirmed that it was the 5th percentile.

Therefore, the model was used with identical input data to estimate what distance would be needed to meet the design specification assuming the site boundary or plant location could be modified. This distance was determined to be about 700 meters. Ultimately, the decision was made to relocate the plant within the Bellefonte site. This resulted in a site boundary distance of about 805 meters. Model analysis with the same assumptions, other than the distance, indicates that the site parameter χ/Q specifications are satisfied. Figure 3 illustrates the original and revised location of the plant versus the site boundary.

Figure 3 - Bellefonte Arial View

Conclusions

Meteorological data were collected at the Bellefonte site in Northern Alabama from 1972 to 1983 related to a planned light-water nuclear reactor. When TVA decided to stop construction of the plant, the meteorological data were archived, along with related metadata, for possible other uses. This proved to be very useful when the site was selected for possible construction of a passive-reactor design by NuStart Energy. The data were used in an atmospheric dispersion factor analysis related to the design specification. Availability of representative onsite data was critical to this analysis.

This analysis points out the importance of ensuring that key site parameters are met before finalizing site selection and prior to completion of the combined operating license application. Although most sites are expected to meet the site parameters, the proximity of the initial plant location to the site boundary at Bellefonte could have caused the χ/Q specification to not be met.

Finally, a thorough understanding of the basis for the key site parameters is important to ensure that any analysis performed is consistent with the design assumptions.

References

1. TVA Internal Report, “Windflow Study at Bellefonte Nuclear Plant Final Report,” Kenneth G. Wastrack, January 1994.
2. U. S. Nuclear Regulatory Commission, “Standard Review Plan,” NUREG/CR-0800, Draft Revision 3, April 1996.
3. American Nuclear Society, “Determining Meteorological Information at Nuclear Facilities,” ANSI/ANS-3.11-2005.
4. U. S. Nuclear Regulatory Commission, “Atmospheric Models for Potential Accident Consequence Assessments at Nuclear Power Plants,” Regulatory Guide 1.145, Revision 1, November 1982.
5. U. S. Nuclear Regulatory Commission, “PAVAN: Atmospheric Dispersion Program for Evaluating Design Basis Accidental Releases of Radioactive Materials from Nuclear Power Stations," NUREG/CR-2858, November 1982